UNITED STATES PATENT AND TRADEMARK OFFICE

I, Derek Ernest LIGHT BA, BDÜ,

translator to RWS Group plc, of Europa House, Marsham Way, Gerrards Cross, Buckinghamshire, England declare;

1. That I am a citizen of the United Kingdom of Great Britain and Northern Ireland.

2. That I am well acquainted with the German and English languages.

3. That the attached is, to the best of my knowledge and belief, a true translation into the English language of the specification in German with the Siemens reference 2002P17538US01 SHZ/JAE and Schiff Hardin & Waite docket number P02,0627-01, claiming the benefit of provisional application serial number 60/430,035,
filed November 29, 2002.

4. That I believe that all statements made herein of my own knowledge are true and that all statements made on information and belief are true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the patent application in the United States of America or any patent issuing thereon.

D. L. Light

For and on behalf of RWS Group plc
The 24th day of November 2003

Description

Display and control element for an X-ray unit

The invention relates to a display and a control element for an X-ray unit.

In clinical work environments, rational working methods and a high degree of automation are demanded in order to allow efficient and economic working. Rationalization in radiological departments have reduced the break intervals between X-ray shots to such a great extent that the time required for an X-ray tube which is in operation to cool down is often no longer achieved in the break intervals. Furthermore, peak traffic operation occurring in emergency diagnostics can also occasionally result in the break intervals being shortened to a critical degree in no time.

Particularly susceptible to destruction as a result of overheating is the anode plate in a X-ray tube. The temperature of the anode plate can be monitored by measurement, or the thermal loading thereof can be simulated in a tube load computer using a computation model. Limit values for the thermal loading are prescribed by the manufacturer according to the tube type. When a thermal loading limit is reached, whether it be as a result of said limit being exceeded or as a result of the immediate imminence of said limit being exceeded, which could result in the X-ray tube or the anode plate being damaged, the X-ray unit automatically prevents or blocks the triggering of an X-ray shot until the necessary cooling time has passed. In addition, a display or a warning signal informs the operator that the thermal loading limit has been reached.

When the reaching of a thermal loading limit is signaled, it is, however, possible to force further X-ray shots even though they are blocked, in principle, by the X-ray unit. This can be provided for medical reasons, for example. To this end, it is known practice to provide a separate key which an operator needs to operate in order to release the X-ray unit's blocking mechanism. It is then possible to use the normal shoot key to trigger an X-ray shot as normal. The need for a separate key to be operated is intended to ensure that the operator is aware under all circumstances that when forcing the X-ray shot there is the risk of damage to the X-ray tube or to the anode plate.

To inform the operator about the loading state of an X-ray tube, **DE 100 39 416 A1** has disclosed a display which an X-ray unit, upon reaching a loading limit, uses to display the remaining cooling time which needs to pass in order for the X-ray tube to cool down sufficiently. An operator can use this time display to optimize his working sequence, for example. In addition, particularly in hurried cases, e.g. in emergency diagnostics, there can be a better estimation of whether the necessary cooling time is acceptable. On the basis of this, the operator can better decide whether X-ray shots need to be forced despite the loading limit having been reached.

A drawback of the known display and control elements is that the operator needs to direct his attention to two different elements of the X-ray unit in order to force X-ray shots. To detect the remaining cooling time after the loading limit has been reached, the operator needs to look at the cooling-time display. To release the X-ray unit's blocking mechanism, he needs to look at the separate, detached key for debblocking. When the deblocking key has been operated, an X-ray shot can be

triggered by operating the shoot key, as a third element needing to be visualized.

Particularly with regard to X-ray units' displays, which are becoming ever more comprehensive and full of information, the need to devote attention to a plurality of separate elements for one and the same procedure is confusing, complicated and takes up an unnecessary amount of time. When working under a high level of strain and with a high level of time pressure, for example in emergency medicine, this can easily result in the information on the cooling-time display no longer being given any attention at all. Instead, an operator under the stress of a medical emergency situation will readily operate the separate deblocking key immediately upon reaching the loading limit, without purposefully also paying attention to the cooling-time display beforehand.

It is the object of the invention to provide an X-ray unit having a cooling-time display and having an deblocking key for the purpose of forcing X-ray shots despite a thermal loading limit having been reached, in which the deblocking key and the cooling-time display can be detected and operated quickly and intuitively.

The invention achieves this object by means of a display and a control element having the features of the first patent claim.

A basic idea behind the invention involves combining the cooling-time display and the deblocking key for forcing X-ray shots with one another and linking them to form a single, common break-time key. The break-time key as a combined key and display element can advantageously be detected at one glance and hence quickly. In addition, the combination results in elements with associated content also being brought

together visually, which makes operating the X-ray unit more intuitive and ergonomic.

In one advantageous refinement of the invention, the break-time key is used not just for displaying the remaining cooling time and for deblocking the next X-ray shot but also permits immediate triggering of the next X-ray shot in addition to the deblocking. This makes the detection and operation of a further, additional control element unnecessary and saves a further control step. At the same time, the display functionality continues to ensure that it is clear to an operator that by triggering the X-ray shot there is a risk of damage or destruction.

Other advantageous refinements of the invention are covered by the dependent patent claims.

Exemplary embodiments of the invention are described in more detail below with reference to schematic figures, in which:

figure 1 shows an X-ray unit with a break-time key in line with the invention,

figure 2 shows a break-time key in which the period of time is displayed in units of time,

figure 3 shows a break-time key which displays the period of time as a percentage,

figure 4 shows a break-time key which displays the period of time symbolically,

figure 5 shows a control device with a break-time key.

Figure 1 schematically shows an X-ray unit 1 which, in the case of the present exemplary embodiment, comprises

a patient table 2 (indicated merely schematically), which is supported by a mounting apparatus (not shown in figure 1), and a support apparatus 3 carrying an X-ray source 4. An X-ray image cassette 5 arranged on the patient table 2 is used for obtaining an X-ray image using an X-ray beam 6 which is emitted by the X-ray source 4 and is attenuated upon passing through an examination object 7 (shown merely schematically), the marginal rays of said X-ray beam 6 being shown in dashes in figure 1.

In addition, an X-ray tube (not shown in figure 1) in the X-ray source 4 is connected to an X-ray generator 9 by means of an electric line 8. A control device 10 arranged in the housing of the X-ray generator 9 uses a computer program to control the X-ray generator 9 during the X-ray shot such that the operational values input using a control device 11 prior to the X-ray shot observe a tube voltage and a quantity of electricity. The control device 11 is arranged on a control desk 12 and is connected to the control device 10 by means of an electric line 13. The control device 10 prevents or blocks the triggering of X-ray shorts upon reaching a thermal loading limit, whether as a result of an X-ray tube's or anode plate's loading limit being exceeded or as a result of the exceeding thereof being immediately imminent. It is possible to ascertain that the loading limit has been reached by measuring the temperature of the anode or by recording the quantity of electricity which has flowed through the X-ray tube for each time, for example.

The X-ray unit 1 comprises an inventive break-time key 14 which is arranged on the control desk 12. The break-time key 14 incorporates a display of the period of time which the X-ray tube in the X-ray source 4 of the X-ray unit 1 needs, having reached a loading limit on account of the thermal loading of previous X-ray

shots, to obtain a sufficient distance from the loading limit again. The break-time key 14 also incorporates a functionality as a key. To this end, it is alternatively in the form of an element on a touch-sensitive screen (touch screen), in the form of an element on a non-touch-sensitive screen, or in the form of a mechanical key with additional display functionality, e.g. in the form of LEDs or LCDs. When the break-time key 14 is operated by pressing a key, the X-ray generator's block is lifted, which means that the triggering of X-ray shots can be forced despite the loading limit having been reached.

The period of time for cooling which is displayed by the integrated break-time key 14 can be ascertained, by way of example, using a computer (not shown in figure 1) in which cooling curves for an anode in the X-ray tube are stored and by measuring the temperature of the anode.

Figures 2 to 4 show options for the design of the cooling-time display for the break-time key 14 (which is not shown in detail in figure 1). In this case, it is of no matter whether the break-time key 14 is a touchscreen element or is in another form.

The display 20 incorporated in the break-time key 14 and shown schematically in **figure 2** shows the period of time required for the X-ray tube to cool down in units of time, that is to say the period of time until the X-ray unit 1 shown in figure 1 is operational again. The period of time is counted down in the manner of a countdown. In the case of the exemplary embodiment of the display 20 which is shown schematically in figure 2, the period of time which still remains until the X-ray tube is operational again is shown in minutes and seconds. Alternatively, other units of time could be chosen. In addition, the break-time key 14 displays

advice 24 ("Press to lift limit") indicating that operating it allows the block on the next X-ray shot to be lifted.

In the case of the present exemplary embodiment, the X-ray tube still needs three minutes and twelve seconds until it is operational again. When the break-time key 14 has been operated, the period of time continues to be displayed.

Figure 3 schematically shows a display 21 which is incorporated in the break-time key 14 and displays the period of time for the X-ray tube to cool down as a percentage. If the display 21 displays 100%, this can mean, by way of example, that the X-ray unit 1 has turned off at present on account of a risk of overheating. The percentage on the display 21 is thus a measure of the remaining period of time in relation to the total period of time of a cooling phase for the X-ray tube at present. In addition, the break-time key 14 displays, as previously in figure 2, advice 24 ("Press to lift limit") indicating that operating the break-time key 14 allows the block on the next X-ray shot to be lifted.

Figure 4 schematically shows a display 22 which is incorporated in the break-time key 14 and displays the period of time for the X-ray tube to cool down symbolically. In the case of the present exemplary embodiment, the period of time is shown using a bar 23 whose length 1 is variable. When the bar 23 is at its maximum length l_{max}, for example, this can mean, by way of example, that the X-ray unit 1 has turned off at present on account of a risk of overheating. The length 1 of the bar 23 is thus a measure of the remaining period of time in relation to the total period of time of the X-ray tube's cooling phase at present. In addition, the break-time key 14 displays, as previously

in figure 2 and figure 3, advice 24 ("Press to lift limit") indicating that operating the break-time key 14 allows the block on the next X-ray shot to be lifted.

Combinations of the displays 20 - 22 and 24 for the break-time key 14 which are shown in figures 2 to 4 and are described are also possible. In addition, the break-time key 14 can also be switchable between the displays 20 - 22 and 24.

Figure 5 shows a control device 11 in line with the invention, in this case in the form of a touchscreen. The control device 11 displays all the elements which can be used to select or set the operational values for the X-ray unit 1. It has an area in which an operational-value display 25 shows all the current settings and an area for inputting operational values 26, said area being able to be used by an operator to set all the operational values for the X-ray unit 1. Settings which an operator makes in the operational-value input 26 are immediately displayed in the operational-value display 25. The display and setting elements do not need any more detailed discussion in order to explain the invention.

The operational-value display 25 also contains a break-time key 14 in line with the invention. This is shown symbolically as a clock in figure 5. For display purposes, there are also other variants available, however, e.g. those explained previously in figure 2, figure 3 and figure 4. When the control device 10 establishes that a thermal loading limit for the X-ray tube has been reached or is immediately imminent, the break-time key 14 on the control device 11 is either revealed or is visually highlighted with clarity. The revelation or highlighting signals that the break-time key 14 has been activated and that a thermal loading limit has been reached. The break-time key 14 activated

in this manner expediently has a design which makes it clearly discernible and conspicuous, e.g. through the use of a signal color or as a result of it flashing. It can also be in visually enhanced form as a prominent key. It is in a form such that an operator can immediately recognize it despite the extreme wealth of information on the control device 11.

By means of the symbolic display used in the form of a clock, the break-time key 14 shows the remaining period of time which is required in order for the X-ray tube to cool down after it has reached a thermal loading limit. When this cooling time has passed, the break-time key automatically returns to the visual background. If an X-ray shot needs to be taken before the cooling time has passed, however, then an operator needs to deblock this shot by operating the break-time key 14. The X-ray shot can then be triggered in the usual way by operating a shoot key (not shown in more detail). The separate activation and operation of the break-time key 14 ensure that an operator is clear about the risk of damage to the X-ray tube as a result of triggering an X-ray shot.

In one particular refinement of the invention, operating the break-time key 14 not only deblocks the next X-ray shot but also simultaneously triggers the X-ray shot. This saves one work step for an operator, since he does not first additionally need to visualize and operate the shoot key.

The integration of various display and control functionalities in the break-time key 14 thus increases the visual order of the control device 11 and makes it easier to operate.